REMARKS

Claims 1-22 are pending in this application. Claims 1-22 are rejected. Claims 1 and 19 have been amended. No new matter has been added. It is respectfully submitted that the pending claims define allowable subject matter.

Claims 1-3, 5-10, 12 and 14-18 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over Koch et al. (U.S. Patent 6,960,879) in view of Amitani et al. (U.S. Patent 6,476,394. Applicant respectfully traverses the 35 U.S.C. § 103(a) rejection.

Koch et al. describes a system for correcting distortion of an image intensifier including means for projecting onto a primary screen a location test pattern (abstract). More particularly, an intensifier includes means for projecting a location test pattern onto a primary screen 4. These means may include, for example, a window 16 located in an envelope 3. The window allows radiation 17, different from X-radiation, to illuminate the primary screen 4. The window 16 is positioned on the envelope 3 in such a way that the radiation 17 can illuminate approximately the entire surface of the primary screen 4. The window 16 is located in such a way that the radiation 17 illuminates the primary screen 4 on the opposite face from that which receives the X-radiation (column 3, lines 18-32).

An optical device includes a source 21 that emits the radiation 17. The source 21 is advantageously monochromatic and focused by means of a lens 22 onto the primary screen 4. To produce the source 21, a solid-state laser may be used, such as a pointer. The wavelength of the laser is chosen so that the photocathode 11 is sensitive at this wavelength. The beam of radiation 17 thus focused is reflected off the surface of a diffraction grating 23 in order to be sent onto the primary screen 4 onto which the radiation 17 is focused (column 3, lines 40-50). The means 16 may comprise a prism 30 with the diffraction grating 23 placed on a third face 33 of the prism 30. The diffraction grating 23 may be produced directly on the face 33 of the prism 30. The diffraction grating 23 also may be produced on a substrate 34 separate from the prism 30. The substrate 34 is then cemented to the face 33 using an optical cement 35 of the same optical index as the prism 30. This same cement may also be used to cement the face 32 of the prism 30 to the window 16 (column 3, lines 51-67).

The diffraction grating 23 may, for example, be produced using a periodic pattern or holography with t he source 21 is rigidly fixed to the envelope 3. It is also possible to use a part 44 of the secondary screen 5 as a window for introducing the radiation 17 into the envelope 3. This part is then made transparent to the radiation 17. For example, when the secondary screen 5 has a phosphor-based scintillator material intended to convert the electrons emitted by the photocathode 11 into visible radiation, the phosphor is removed from the secondary screen in the part 44 so as to allow the radiation 17 to penetrate the envelope 3. The source 21 is located near the secondary screen and a prism 40 is used, for example, to send the radiation 17 onto the primary screen 4 Column 4, lines 1-23).

The image intensifier also includes means for analyzing the distribution of the plurality of points of the location test pattern 41 that are received by the secondary screen 5. The distortion is measured by analyzing the distribution of the points in the image 42 of the location test pattern 41. The measurement may be absolute and the analysis includes comparing the distribution of points in the image 42 relative to a theoretical distribution. The measurement may be relative and, in this case, the comparison is made relative to an image 42 produced in a calibration phase during which the distortion of the image is controlled (column 4, lines 42-57).

Amitani et al. describes a radiation image capturing apparatus having a calibrating device (abstract). At certain points or after a certain time has passed, one of a plurality of calibration practicing means drives automatically an X-ray tube 1, a radiation image detector, and an image processing section 3 to perform calibration. In particular, a signal value is obtained from each of a plurality of the pixels in both (i) the case of no application of radiation and (ii) in the case of uniform application of radiation without being transmitted through the object, to obtain image data for correction (correction data), which is stored in a memory means 32 (column 16, line 54 to column 17, line 31). Further, geometric corrections may be performed, including, for example, parallel shifts, rotation, enlargement and reduction after making a correction of distortion (column 20, lines 3-9). Calibration may be performed using a single sample of a repetition pattern disposed on a surface or generated by a light source. This pattern allows for positional correction by image processing to obtain a correct image. The line width of the repetition pattern 70 is 3 pixels or less on the final output image. In the case where the magnitude of the signal value of the pixels corresponding to the repetition pattern 70 is lowered to a half or less of the value for the no

repetition pattern 70 being provided, the signal value of the pixels corresponding to the line or dot portion of the repetition pattern 70 is interpolated by using the information on the signal value of the surrounding pixels, and a correct image of an object can be obtained (column 20, line 28 to column 22, line 64).

Claim 1, as amended, recites a method for calibrating an X-ray imaging system comprising "generating a calibration image within an X-ray imaging system using the calibration image source only in the absence of X-rays." The combination of Koch et al. and Amitani et al. fails to describe or suggest a method as recited in amended claim 1.

The Office Action points to column 18, lines 35-44 of Amitani et al. to make of for the deficiencies of the Koch et al. reference and indicating that a plurality of calibration images are captured. However, at least some signals are acquired while radiation is being applied in order to obtain image data for correction. In contrast, the method recited in claim 1, as amended, includes generating a calibration image only in the absence of X-rays. Accordingly, no calibration image is generated while applying any radiation and no signals are acquired while radiation is being applied. Thus, the combination of Koch et al. and Amitani et al. does not describe or suggest a method as recited in claim 1.

Claims 2, 3, 5-10 and 12 depend from independent claim 1. When the recitations of claims 2, 3, 5-10 and 12 are considered in combination with the recitations of claim 1, Applicant submits that dependent claims 2, 3, 5-10 and 12 are likewise patentable over the combination of Koch et al. and Amitani et al. for at least the same reasons set forth above.

Claim 14 recites a method for determining distortion in an X-ray imaging system comprising "comparing to the light pattern output of the calibration image source a plurality of outputs produced by the image intensifier that are interpolated." The combination of Koch et al. and Amitani et al. fails to describe or suggest a method as recited in claim 14.

The Amitani et al. reference fails to make up for the deficiencies of the Koch et al. reference as the system of Amitani et al. only produces a single repetition pattern and performs a single sample to provide positional correction. Further, when the magnitude of the signal value is lowered to half or less, interpolation of pixels corresponding to a line or dot portion of the repetition pattern is interpolated using information on signal value of the surrounding pixels (i.e., for a single image output). However, in contrast to the method

recited in claim 14, Amitani et al. does not describe or suggest performing interpolation on a plurality of outputs as recited in claim 14. There is simply do description or suggestion of interpolating pixels in more than one repetition pattern. Interpolation is only performed on a single output, namely a single repetition pattern output. Thus, the combination of Koch et al. and Amitani et al. does not describe or suggest a method as recited in claim 14.

Claims 15-18 depend from independent claim 14. When the recitations of claims 15-18 are considered in combination with the recitations of claim 14, Applicant submits that dependent claims 15-18 are likewise patentable over the combination of Koch et al. and Amitani et al. for at least the same reasons set forth above.

Claims 4, 13 and 19-22 have been rejected under 35 U.S.C. § 103(a) as being unpatentable over the combination of Koch et al. and Amitani et al. and further in view of Quadflieg et al. (U.S. Patent 6,086,252). Applicant respectfully traverses the 35 U.S.C. § 103(a) rejection.

Koch et al. and Amitani et al. are described and discussed in more detail above.

Quadflieg et al. describes a system for correction of a fixed pattern noise wherein an X-ray image intensifier is provided with a radiation source such as flashlights or LEDs (abstract). Radiation sources 4 are mounted inside an X-ray image intensifier 1. The radiation sources 4 irradiate a photocathode with radiation whereto the photocathode is sensitive. The radiation from the radiation sources 4 may have a wavelength near the wavelength of the radiation generated by a conversion layer. The radiation sources 4 may be flashlights or light-emitting diodes. The radiation sources are arranged such that they emit radiation beams 20 which cover substantially the entire area of the photocathode 3, at a side that is remote from the conversion layer 10, with a spatially uniform intensity. A television camera 15 derives a calibration signal from the light intensity distribution on the exit window 12. Ideally, if there are no perturbations, the uniform intensity distribution generated by the radiation source 4 leads to a uniform light intensity on the exit window and the calibration signal has a constant signal level. The actual calibration signal that is derived from the uniform intensity distribution represents the combined effect of different perturbations that are introduced by irregularities in the photocathode, the electron optics, the exit window with its phosphor layer, the optical coupling 16 from the exit window 12 to the television camera

15 and the television camera 15 itself. The calibration signal can be formed just before or after, within a few seconds, of the formation of an X-ray image of the patient (column 6, lines 18-51).

Further, the television camera 15 derives the primary image signal from a light-optical image. The primary image signal is supplied in the form of an electronic video signal. The electronic video signal has signal levels that represent the brightness at respective positions in the light-optical image on the exit window. The output port of the television camera is coupled to a signal correction unit 30. The signal correction unit 30 generates a corrected image signal. The signal correction unit 30 is coupled to a monitor 25 or to a buffer unit 26. The image information of the X-ray image is displayed on the monitor 25. The corrected image signal may also be applied to the buffer unit 26 and be further processed later or be printed as a hard-copy (column 6, lines 52-65).

The signal correction unit 30 corrects the primary image signal for perturbations introduced in the conversion of the low-energy radiation image from the conversion layer 10 into the primary image signal. To that end the signal correction unit 30 comprises a multiplier 31 that multiplies the primary image signal by correction numbers. The correction numbers are stored in a memory unit 32. In order to carry-out accurate correction, the radiation sources 4 are briefly activated by a control unit 33, just before or after the actual X-ray image of the patient is formed. The radiation sources 4 mutually illuminate the photocathode 3 with a substantially uniform intensity distribution, i.e., the calibration low-energy radiation intensity distribution. As a consequence the television camera 15 generates the calibration signal that is fed to the signal correction unit 30. The calibration signal is applied to an arithmetic unit 34 via a switching unit 35. The switching unit is operated by the control unit 33. The arithmetic unit 34 derives the maximum signal level from the calibration signal and calculates the respective ratios of the signal levels to the maximum signal level. These ratios form the correction numbers that are stored in the memory unit 32. Any deviations of the correction numbers from unity represent perturbations. When the memory unit 32 is updated with accurate correction numbers, the control unit operates the switching unit 35 in order to apply the primary image signal to the multiplier 31. The perturbations in the primary image signal are removed by multiplying the primary image signal by the correction numbers, i.e., multiplying respective signal levels of the primary image signal by respective correction numbers (column 7, lines 16-45).

Claims 4 and 13 depend from independent claim 1. Applicant submits that the Quadflieg et al. reference fails to make up for the deficiencies of the Koch et al. and Amitani et al. references. There is simply no description or suggestion generating a calibration image within an X-ray imaging system using a calibration image source only in the absence of X-rays. Accordingly, when the recitations of claims 4 and 13 are considered in combination with the recitations of claim 1, Applicant submits that dependent claims 4 and 13 are likewise patentable over the combination of Koch et al. and Amitani et al. in view of Quadflieg et al. for at least the same reasons set forth above with respect to claim 1.

Claim 19, as amended, recites a system for determining distortion within an X-ray imaging device comprising "a calibration image source within an image intensifier configured to generate a calibration image pattern at an output of the calibration image source for use in determining distortion within the X-ray imaging device based on a plurality of samplings of a correction image generated from the calibration image pattern only in the absence of X-rays." The combination of Koch et al. and Amitani et al. in view of Quadflieg et al. fails to describe or suggest a system as recited in amended claim 19.

As discussed in more detail above with respect to claim 1, the combination of Koch et al. and Amitani et al. fails to describe or suggest determining distortion within an X-ray imaging device based on a plurality of samplings of a correction image generated from the calibration image pattern only in the absence of X-rays. Even from a cursory reading of the Quadflieg et al. reference, this reference fails to make up for the deficiencies of the Koch et al. and Amitani et al. references. The combination simply does not describe or suggest a system wherein a calibration image pattern at an output of the calibration image source is generated for use in determining distortion within the X-ray imaging device based on a plurality of samplings of a correction image generated from the calibration image pattern only in the absence of X-rays. Accordingly, the combination of Koch et al. and Amitani et al. in view of Quadflieg et al. does not describe or suggest a system as recited in claim 19.

Claims 20-22 depend from independent claim 19. When the recitations of claims 20-22 are considered in combination with the recitations of claim 19, Applicant submits that dependent claims 20-22 are likewise patentable over the combination of Koch et al. and Amitani et al. in view of Quadflieg et al. for at least the same reasons set forth above.

Claim 11 has been rejected under 35 U.S.C. § 103(a) as being unpatentable over Koch et al. and Amitani et al. and further in view of Pradere et al. (U.S. Patent 6,194,700). Applicant respectfully traverses the 35 U.S.C. § 103(a) rejection.

Koch et al. and Amitani et al. are described and discussed in more detail above.

Pradere et al. describes a device with alteration means for conversion of an image using an image intensifier tube by providing a permanent test pattern on the intensifier tube, and more particularly, at an input window of the intensifier tube (abstract). In a first exemplary embodiment, to make the references of one test pattern, a support 20 comprises deformations 23. For example, the deformations 23 are grooves or holes (not through holes) located on the face of the support 20 that receive the radiation 17. At the position of these holes, the absorbent capacity of the support 20 is reduced. The result thereof is a modification of the image formed on the target 6. As a first variant, these hollow deformations 23 are replaced by other hollow deformations 24 made on the face of the support 20 in between this support 20 and the scintillator 19 (or the photocathode 5 which is curved). In this first variant, the resulting reduction of absorption is increased by the deformation, as the case may be, of the growth of CsI at this place. The resulting spot of the image is therefore increased. In a second variant, an input window 25 of the tube 4, formed by the part of the envelope 4 of the tube that faces the input face 18, comprises grooves or holes 26 fulfilling the same role as the holes or grooves 23 and 24 (column 4, lines 41-60). Further, the deformations may be replaced by deformations acting in the negative sense. For example, protuberances 27 may be made on the face of the support 20 that receives radiations 27. These protuberances may also be made on the internal face of the window 25 of the tube 4 (column 5, lines 1-6).

In another method for obtaining the test pattern, a window 28 is provided in the envelope 4 of the tube. The window 28 is outside the field of radiation to be converted. Through this window 28, a laser radiation 29 (essentially a single ray, especially if the source is not a laser source), produced for example by a laser source 30, illuminates the rear face of the photocathode 5. Under the effect of this illumination, the photocathode 5 emits an electron radiation 31 revealing the place where it has been excited by the ray 29. It is possible to obtain a scanning of the rear of the photocathode 5 through the ray 29. Preferably, the emission of the source 30 is pulsed (column 5, lines 25-36). Further, rather

than illuminate the photocathode 5 by the rear, auxiliary light radiation may be let through by means of through holes 32 made throughout the thickness of the support 20 (column 5, lines 55-58). Additionally, a third mode of implementation comprises the making of a grid 33 whose shape perfectly matches the spherical shape of the input window 25. This grid 33 may slide in alternation on the input window 25. The principle of acquisition with this third mode consists in mobilizing the grid, for example making it shift during the useful shot. In this case, bars 34 of the grid 33 distribute their absorption effect throughout the image which is thereby affected uniformly. At the time of acquisition of the image of the test pattern, it is constituted by the grid 33 stopped in a particular position (column 5, line 59 to column 6, line 2).

In operation, an image obtained of the test pattern is memorized in a memory 43 of the image processor 14. This memorized image is, for example, a file registering a collection of addresses, x-axis values and y-axis values corresponding to the points of the grid forming the test pattern. At the time of use, an acquisition is made alternately (or at the same time) of the useful image, that of the patient 2, and that of the test pattern. These images comprise identical deformations. Owing to the position in space of the tube 4 and the disturbances communicated to the tube 4, in this position, by the earth's magnetic field, the grooves 44, 45 made on this test pattern get converted into images 46 and 47, respectively, on the target 6. The resultant deformations are comprehensively S-shaped deformations. The point 48 of concurrence of the grooves 44 and 45, whose position is known by the memory 43, has shifted to the position 49. The processor 14 is capable of processing the image to prepare the coordinates of the images 49 of the points of concurrence 48. Starting from the perfect image of the test pattern stored in the memory 43 and the image, acquired in real time, of the test pattern, the processor 14 performs a comparison 50 and produces a reverse distortion function 51. This reverse distortion function 51 is then applied to the useful image 52 of the patient 2 to produce the corrected image 53 by correction (column 7, lines 6-33).

Claim 11 depends from independent claim 1. Applicant submits that Pradere et al. fail to make up for the deficiencies of the Koch et al. and Amitani et al. references. Pradere et al. describes a system that starts from a perfect image of a test pattern stored in memory and the image, acquired in real time, of the test pattern, and a processor performs a comparison and produces a reverse distortion function. The reverse distortion function is then applied to the useful image of a patient to produce the corrected image. Accordingly,

when the recitations of claim 11 are considered in combination with the recitations of claim 1, Applicant submits that dependent claim 11 is patentable over the combination of Koch et al. and Amitani et al. in view of Pradere et al. for at least the same reasons set forth above with respect to claim 1.

For at least the reasons set forth above, Applicant respectfully requests that the 35 U.S.C. § 103(a) rejection of claims 1-22 be withdrawn.

In view of the foregoing amendments and remarks, it is respectfully submitted that the prior art fails to teach or suggest the claimed invention and all of the pending claims in this application are believed to be in condition for allowance. Reconsideration and favorable action is respectfully solicited. Should anything remain in order to place the present application in condition for allowance, the Examiner is kindly invited to contact the undersigned at the telephone number listed below.

Respectfully Submitted,

Evan R. Sotiriou, Reg. No.: 46,247
THE SMALL PATENT LAW GROUP LLP
Suite 1611
611 Olive Street
St. Louis, MO 63101
314-584-4080